MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2022/2023

BOP2024 – PRINCIPLES OF OPERATION RESEARCH

(All Sections/Groups)

10 July 2023
9.00 am – 11.00 am
(2 hours)

INSTRUCTION TO STUDENT

1. This question paper consists of **SIX (6)** pages including a cover page with **FOUR (4)** Questions only.
2. Attempt **ALL** the questions.
3. Please write all your answers in the Answer Booklet and Graph Papers provided.
4. The distribution of the marks for each question is given. Total marks 100.

QUESTION 1 (25 MARKS)

a) A plastic company produces two sizes of containers. X_1 medium and X_2 large. The containers are produced in 10,000 container lots. The containers are processed through a molding operation and a thermoforming operation. The company has 30 days available for both molding and thermoforming. A lot of medium-size containers require 2 days of molding and 4 days of thermoforming, whereas a lot of large containers require 4 days to mold and 2 days to thermoform. A lot of medium-size containers earn \$800 profit, and a lot of large-size containers earn \$900 profit. In order to fulfill its obligations under a shipping contract, the company must produce at least nine lots. The company wants to determine the number of lots to produce of each size can (X_1 and X_2) in order to maximize profit.

i) Construct a linear programming model for this problem. (5 marks)

ii) Solve this model by using graphical analysis. (7 marks)

b) The following are linear programming problems for a company. Constraints 1 and 2 are the binding constraints.

Max $2X_1 + X_2$
s.t.
$4X_1 + X_2 \leq 400$
$4X_1 + 3X_2 \leq 600$
$X_1 + 2X_2 \leq 300$
$X_1, X_2 \geq 0$

i) Compute the range of optimality for X_1 (2 marks)

ii) Compute the range of optimality for X_2 (2 marks)

c) Amy is considering attending one of the following four universities. The criteria for selection, weights, and school ratings are shown in the following table. Use the scoring model to determine the best choice for Amy.

Table: The criteria of selection, weights, and school ratings

Criteria	Weight	Ratings			
		HU	CU	MIT	BJU
Facilities	3	6	5	7	6
School Fee	4	5	8	3	6
Curriculum program	3	9	5	4	6
Management quality	5	8	6	7	5
Academic' quality	4	5	3	8	5
Graduates' quality	4	3	5	8	7
Average class size	3	4	5	8	7
Distance from home	2	7	8	7	6

(9 marks)

Continued...

QUESTION 2 (25 MARKS)

a) Healthy Elderly Foods Sdn Bhd is an elderly food company that produces organic cereals and organic snacks. All the ingredients used in the production are mainly produced by the company except carrots; bananas and apples. These three ingredients need to be sourced from suppliers. The organic cereal uses one portion of carrot; one portion of banana and one portion of apple, whereas the organic snack uses two portions of carrot; one portion of banana, and two portions of apple. The profit for both elderly food products is $800 each.

The company has a goal to make at least $100,000 profit weekly. The suppliers can provide Healthy Elderly Foods Sdn Bhd with 1200 portions of carrots, 600 portions of bananas, and 800 portions of apples on a weekly basis. It takes 1 hour to produce one unit of elderly cereal and 1.5 hours to produce one unit of elderly snacks. The company needs to meet a contract of 350 units of elderly snacks and produce at least 500 units of both food products weekly. A total of 480 hours of labor are available weekly. Demonstrate the goal programming model.

(13 marks)

b) Refer to the following linear programming problem.

Max $140X + 100Y$
s.t.
$4X + 2Y \leq 200$
$8X + 6Y \leq 480$
$X, Y \geq 0$

i) Modify the constraints into equations with slack variables. (2 marks)

ii) Present the initial simplex tableau. (3 marks)

iii) Produce the pivot column. (2 marks)

iv) Discover the pivot row and pivot number. (2 marks)

v) Compute the second simplex tableau. (3 marks)

Continued...

QUESTION 3 (25 MARKS)

a) Redberries are to be transported from three plantation regions to two canneries. Intermediate stops at a consolidation station are possible.

Plantation	Supply	Station	Cannery	Capacity
Arizona	1200	South	Yopal	2500
Boyang	1500	North	Zion	3000
California	2000			

Shipment costs are shown in the table below. Where no cost is given, shipments are not possible. Where costs are shown, shipments are possible in either direction. Sketch a network model diagram for this problem.

	A	B	C	S	N	Y	Z
Arizona		1		5		3	
Boyang				4	5		
California				6	3		
South					2	2	4
North						5	9
Yopal							2
Zion							

(12 marks)

b) Super Accounting Sdn Bhd is an accounting firm that has three new clients (Hani, Fane, and Ravi). Project leaders will be assigned to the three clients. Based on the different backgrounds and experiences of the leaders, the various leader-client assignments differ in terms of projected completion times. The possible assignments and the estimated completion times in days are as follows:

	Clients		
Project Leader	**Hani**	**Fane**	**Ravi**
Ang	6	9	17
Kali	8	12	21
Hafiz	11	12	17

Show the new network representation of this problem. (10 marks)

c) Present any **TWO (2)** advantages of simulation. (3 marks)

Continued...

QUESTION 4 (25 marks)

a) Consider the following linear program:

$$\begin{aligned} \text{Max} \quad & 3X_1 + 4X_2 \\ \text{s.t.} \quad & X_1 + 3X_2 \leq 12 \\ & 2X_1 + X_2 \leq 8 \\ & X_1 \leq 3 \\ & X_1, X_2 \geq 0 \end{aligned}$$

The Management Scientist provided the following solution output:

OPTIMAL SOLUTION

Objective Function Value = 20.000

Variable	Value	Reduced Cost
X_1	2.400	0.000
X_2	3.200	0.000

Constraint	Slack/Surplus	Dual Price
1	0.000	1.000
2	0.000	1.000
3	0.600	0.000

OBJECTIVE COEFFICIENT RANGES

Variable	Lower Limit	Current Value	Upper Limit
X_1	1.333	3.000	8.000
X_2	1.500	4.000	9.000

RIGHT-HAND SIDE RANGES

Constraint	Lower Limit	Current Value	Upper Limit
1	9.000	12.000	24.000
2	4.000	8.000	9.000
3	2.400	3.000	No Upper Limit

i) Show the optimal solution and the total maximum profit received. (3 marks)

ii) Assume that the profit on X_1 is increased to \$7, is the above solution still optimal? Compute the total maximum profit received in this scenario? (3 marks)

Continued...

iii) If the unit profit on X_2 was \$10 instead of \$4, predict whether the optimal solution would change. (3 marks)

iv) If simultaneously the profit on X_1 was raised to \$5.5 and the profit on X_2 was reduced to \$3, predict whether the current solution still remains optimal. (4 marks)

b) Using the example, illustrate any **THREE (3)** types of Queuing System Models. (12 marks)

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